NUCLEAR ENERGY RESEARCH INITIATIVE

Flexible Conversion Ratio Fast Reactor Systems Evaluation

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Project Description

The objective of this project is to develop a feasible design for a flexible conversion ratio reactor system that would enable time-dependent management both of fissile inventories and higher actinides. The goal is to produce a single reactor design capable of being configured to achieve 1) conversion ratios near zero in order to transmute legacy waste and 2) conversion ratios near unity such that the reactor can operate in a sustainable closed cycle. Two candidate liquid coolant core designs--lead and liquid salt-- will be developed and compared to find the most promising approach. The results of these two designs will also be cross compared against supercritical carbon dioxide and sodium-cooled reactor designs.

A consistent plant rating of 2,400 MWt will be used and all reactor cores will be cooled by forced circulation during normal operation to achieve high power density of at least 100 kilowatts/liter. To be more economically competitive, power conversion systems will be selected that eliminate the intermediate heat transfer loop. Safety and core integrity will be achieved through a self-controllable reactor design that ensures safe shutdown for all key transients. Proliferation resistance will be enhanced by eliminating blankets and using transuranics as fuel without separating plutonium.

The outcome of this project will be core designs with a flexible conversion ratio for lead alloy and liquid salt coolants. This outcome, together with another NERI project on gas- cooled reactors being performed at MIT and work at the Argonne National Laboratory, will allow decision makers to consistently compare various large, economical, high-power density fast reactor concepts. Ultimately, this will help in the selection of the most attractive system for closed fuel cycles in countries with fuel service centers.

Workscope

The following tasks will be performed:

- Develop lead alloy-cooled reactor designs with unity and zero conversion cores
- Develop liquid salt-cooled reactor designs with unity and zero conversion cores
- Cross compare the various designs
    - Assemble data for sodium-cooled and gas-cooled fast reactors
    - Compare sodium-, gas-, lead alloy-, and liquid salt-cooled reactors